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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

JUNE 12, 1989

TOMORROW'S LEADERS

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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

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COVER STORY

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Innovation. Protectionism. Global competitiveness. Manufacturing's future. If these are the most pressing issues facing U.S. electronics and computer companies today, then their weight lies squarely on the talent of tomorrow's leaders — the Class of 1989. ELECTRONIC BUSINESS taps a sampling of the best and brightest minds among engineering and business school students at the country's top institutions. What they say is worth listening to.

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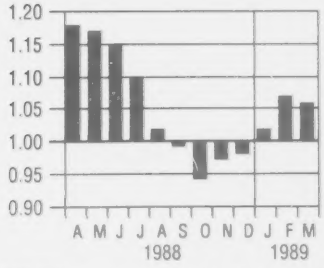

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61 Coining it: Top U.S. firms show 12% profits gain

Paced by the high-flying semiconductor, systems and government groups, the elite of the U.S. electronics industry posted another hefty year-to-year gain in profitability last year. The ELECTRONIC BUSINESS top 100, the industry's most profitable public companies, increased their 1988 after-tax profits nearly 12% over the weighted average in 1987.

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Market's message

The history of electronics is replete with solutions looking for problems — one of the latest, perhaps, being gallium arsenide semiconductors. As our new associate editor Mike Leibowitz reports, the GaAs chip makers are now beginning to find a wider range of applications for these blindingly fast devices by slowing them down a tad and making them more compatible with conventional silicon chips. Seems simple, doesn't it? Listen to the marketplace is the message, says Mike.

It's a message that Mike has heard before when he was a field sales engineer for Intel, selling microprocessors to a variety of industrial accounts, so he knows how to listen to customers. More recently, he has been marketing himself, as a successful freelance writer following his graduation from Boston University's school of journalism. He did that so well, appearing in the pages of *High Technology, Business, Omni,* and *Computerworld,* to say nothing of regular contributions to ELECTRONIC BUSINESS, that we persuaded him to listen to us and join our staff full-time.

Mike is no stranger to the offices of ELECTRONIC BUSINESS. When he was studying for his master's degree, he also worked as an intern in our Newton editorial office. Clearly, we're a market Mike understands. In the weeks to come, Mike will be taking a closer look at several of the markets that make up this fascinating business of electronics.

Michael Leibowitz, associate editor

Listen to the future leaders

We've also been getting an earful from some of the brightest minds among the nation's top business and electrical engineering graduates. Associate editor Barbara Berkman and research supervisor Tom Sommers traveled from Boston to Philadelphia, Los Angeles and San Francisco to conduct a series of focus group research sessions with MBA and EE master's graduates at MIT, Wharton, UCLA and Stanford. We listened carefully to these future leaders' views on the worldwide electronics and computer industries, the companies they admire — and detest — and their expectations for the future. These men and women will set the course of America's business future, and their comments hold some important lessons for everyone in the business of electronics.

JEFF BAIRSTOW, executive editor

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Europe begins to raise the barriers to imported ICs

Higher prices and IC shortages could result from a ruling requiring local wafer diffusion for a "Made in Europe" label

A recent ruling by the European Community (EC) could lead to artificial shortages and higher prices for semiconductors in Europe. The new rule regards ICs as "imported" unless the wafers undergo diffusion within the Community borders. The EC's Rules of Origin Commission is trying to ensure that "Made in Europe" computers and telecommunications equipment have a high level of locally made components.

The move is part of a general Community policy intended "to eliminate 'screwdriver' assembly factories," according to an EC spokesman. The ruling does not actually ban chips that are diffused in Japan or the United States and assembled in Europe, since there are no actual import quotas on semiconductors. But the move puts considerable pressure on OEMs that use the chips to make "Made in Europe" hardware. European hardware makers will have to include at least 60% local content in their equipment to avoid the payment of import duties.

"European hardware makers face a difficult choice," says Daniel Newman, an analyst at the consulting group Ernst & Whinney in Brussels. Either manufacturers will have to pay more for locally produced chips, he says, "or they could lose the right to call their machines European-made and their products will become subject to import duties. It may seem paradoxical that an Italian company like Olivetti should have to pay customs charges on the computers it manufactures in Italy, but that's what we could be seeing."

Bruno Lamborghini, director of research and strategy at Ing. C. Olivetti & Co., Europe's largest computer producer, stops short of calling the measure protectionist, but concedes that it is going to make life more difficult for Olivetti. "We do want European components," Lamborghini says, "but we expect to be able to buy them at competitive prices."

The ruling hits hardest at Japanese chip makers such as Toshiba Corp. and Hitachi Ltd. These producers assemble semiconductors in European factories, but diffuse them in Japan. Hitachi, for example, had European semiconductor sales of $320 million in 1988, but none of its chips undergo diffusion within the EC. Hitachi's products will now be counted as im-

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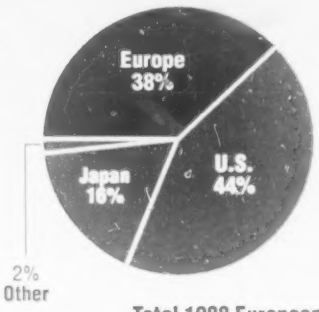
ports. And U.S. producer Intel Corp. is affected by the move, since it diffuses all of its chips in Israel, according to an Intel spokesman. "Israel has a privileged trading status with the EC. One of the many questions raised by the decision is whether that relationship will continue." Intel has asked the EC Commission to have its plant in Israel considered as European.

"Until there is a big ramp-up in European production by Japanese chip makers, the market is going to see an artificial shortage" of chips, says Dennis Exton, European technology analyst at the London stockbroker UBS-Phillips and Drew. "Of Japanese producers that sell in Europe," Exton adds, "only NEC already diffuses some of its semiconductors within the EC." Industry sources claim that foreign producers could take at least two years to gear up for diffusion.

Even before the new law, EC equipment makers imported more than a third of their semiconductors.

Where Europe buys ICs

European semiconductor market by vendor location



Total 1988 European semiconductor market
$8,491 million

Source: Dataquest Inc.

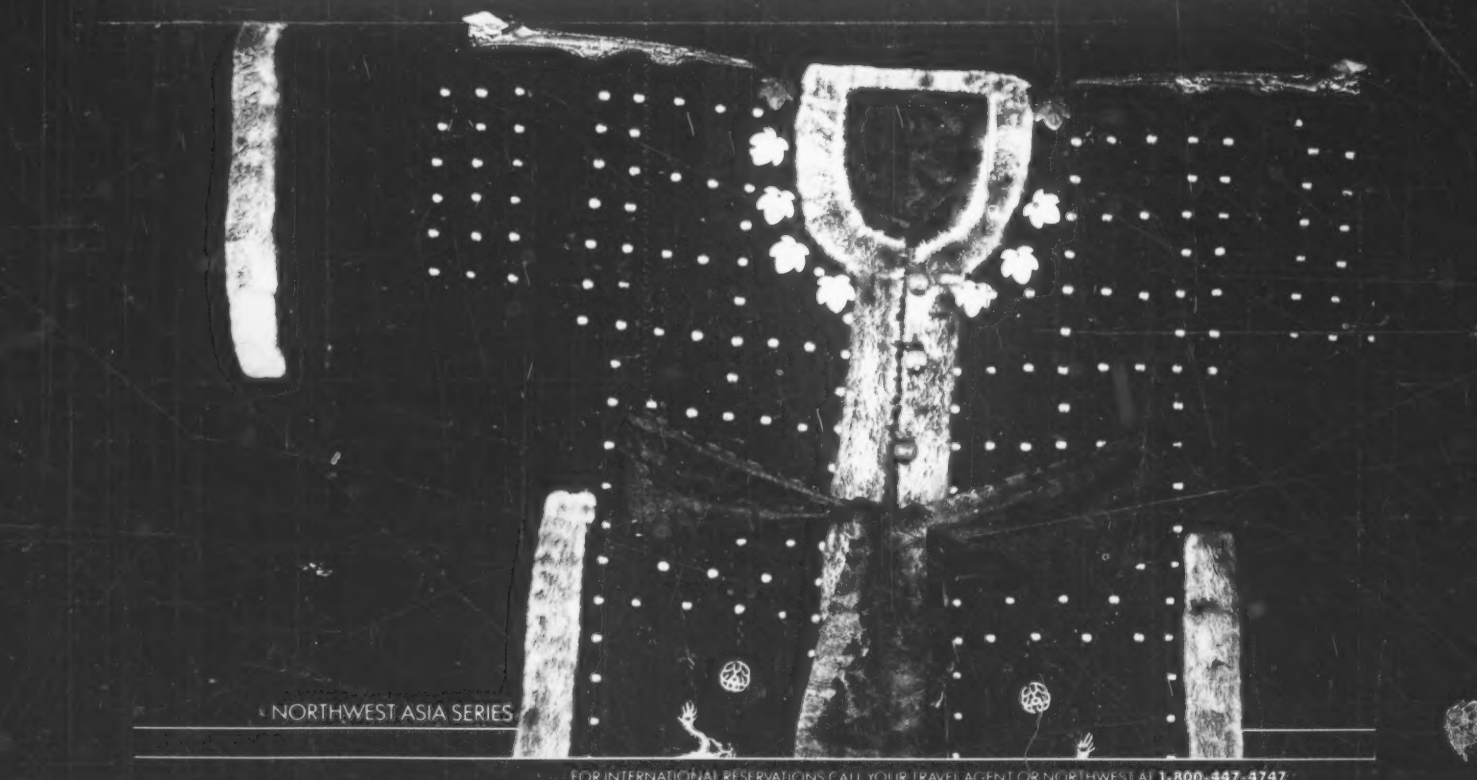
Last year, $8.5 billion in semiconductors were sold in Europe, $5.3 billion of which came from sources outside the Community, according to market research firm Dataquest Inc.

Analysts say it's too soon to estimate what proportion of European chip sales will be considered imported under the new rules, but it will certainly be higher than 50%. One of the areas hardest hit will be the memory market. In the past, hardware manufacturers could choose from several suppliers, including the European divisions of several Japanese companies, which assemble DRAMs in Europe but diffuse them elsewhere.

But under the new rules, West Germany's Siemens AG will be considered the only domestic producer of DRAMs in the Community. Siemens, however, can only supply 20% of the demand.

European prices for Japanese DRAMs may also climb if the commission institutes an antidumping ruling against Japanese-made DRAMs. Currently under consideration, this ruling could result in an accord similar to the U.S. Semiconductor Trade Agreement, which establishes "floor prices" (minimum prices) for Japanese memory chips.

ANDY ROSENBAUM



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Spurned GaAs chip makers resort to Marketing 101

New tactic of targeting silicon-compatible GaAs chips to relieve computer companies' "bottlenecks" is a departure from the past, when the thrust was speed

BY MICHAEL R. LEIBOWITZ

There have been many marketing blunders in the history of the electronics industry, but it is hard to find any more egregious than those committed by makers of digital gallium arsenide chips. For much of this decade, gallium arsenide chip makers have chased obscure markets, ignored potentially lucrative ones, and, in general, have earned the unwelcome reputation as purveyors of an exotic technology that few could afford and even fewer needed.

This could have gone on longer, with GaAs' prospects of hitting the computer mainstream evaporating, and no one missing it. But a new marketing tactic has emerged within the past two years that holds great promise for the tiny $50 million worldwide digital GaAs industry.

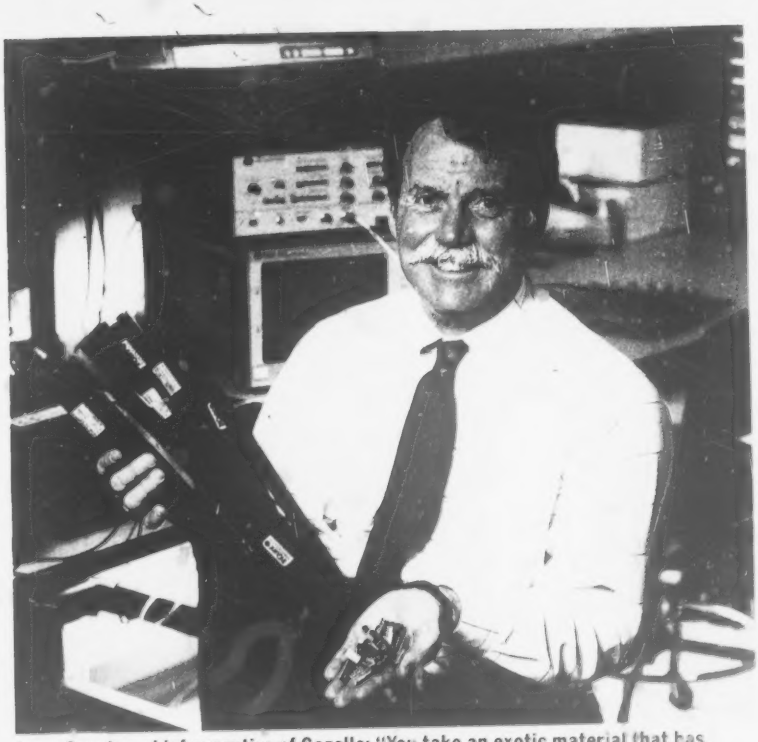
The new tactic involves what seems to be a perfectly obvious idea: trade some of the blinding speed of GaAs chips for other important benefits that system designers covet. This is a major departure from the way GaAs has been marketed in the past and threatens to wrench sales from makers of high-speed silicon chips. Right this minute, companies that never would be imagined using GaAs — makers of mainstream products such as workstations and minisupercomputers — are either considering it or designing it into their products.

GaAs, because of its natural characteristics, allows electrical signals to scream along at four to five times the speed of silicon. But the result has been superfast chips that could not work easily with silicon chips, didn't pack enough circuitry to be useful, and were too expensive. So why not give up some of GaAs' speed to overcome these problems? Specifically, why not turn out GaAs chips that work easily alongside silicon chips so they can be sold as so-called "bottleneck relievers," providing an added fillip of speed to high-traffic areas of a silicon-based computer design?

This idea, called "silicon compatibility," is being pursued by each of today's four U.S. merchant GaAs chip makers — Gazelle Microcircuits Inc., GigaBit Logic Inc., TriQuint Semiconductor Inc. and Vitesse Semiconductor Corp. The concept involves technology enhancements that eliminate the strange power supply requirements of GaAs chips, matching them to the industry-standard power levels of silicon chips. It also involves adding on-chip circuitry that brings GaAs input/output levels in line with those of silicon emitter-coupled logic (ECL) and transistor-transistor logic (TTL) chips. While this slows down the chip somewhat, the resulting chips are at least twice as fast as silicon. Most importantly, such silicon-compatible chips give

Michael Grecco

Lou Tomasetta, chief executive of Vitesse: "The strategy once was, 'Gee, here's this stuff I developed in the R&D lab. Now let me see if I can sell it' "



Jerry Crowley, chief executive of Gazelle: "You take an exotic material that has inherently faster properties and you tame it and make it usable by the masses"

workstation makers a cost effective way to squeeze extra MIPS from a high-end design.

There's another twist to the silicon-compatibility thrust: trim the speed, cram in more circuitry, and emphasize GaAs' low-power advantages over silicon. A 10,000-gate GaAs array slowed so it is only 20% faster than the fastest 10,000-silicon gate ECL chip, for example, runs with less than half the power. Offering such cool-running, silicon-compatible GaAs chips — a route Vitesse is promoting — means potential customers such as minisupercomputer builders can dilute the mix of power-hungry silicon chips in their design, and thus avoid having to add expensive and bulky mechanical cooling systems to their products. "Staying in the air-cooled domain is very important to us," says Steven Wallach, cofounder and vice president of technology at Convex Computer Corp. of Richardson, Texas, the leading maker of minisupercomputers. "Chips get cheaper over time. Mechanics don't."

Once reluctant to trade speed

Trading some speed for these other benefits seems a natural tactic for chip makers, but it was heresy to the first suppliers of digital GaAs. Between 1981 and 1986, companies such as GigaBit Logic and Harris Corp. were fixated on speed, trying to build the fastest parts that GaAs would allow. While they did create parts four to five times as fast, these parts didn't fit well with silicon circuitry and were outrageously expensive. "The strategy," says Vitesse's chief executive, Lou Tomasetta, "was 'Gee, here's this stuff I developed in the R&D lab. Now let me see if I can sell it.'"

Except for a few exotic digital GaAs applications, they couldn't. Chip makers targeted speed-at-any-cost customers such as the military and Cray Research Inc., that could afford to build entire subsystems out of GaAs chips and didn't care much about the lack of silicon compatibility. They loved the technology, but were on such long design cycles that it would be many years before they could generate any significant production volume. And without production volume, the GaAs chip makers were stuck in a vicious circle: Low demand, high costs — and no way to move along the GaAs learning curve to lower costs and increased chip complexity. Instead of topping $1 billion in annual sales by 1988, as had been projected years ago, the digital GaAs IC business, today, is no more than a speck in the $36 billion silicon IC business.

Digital merchant GaAs IC revenue

Silicon compatibility

Enter silicon compatibility. It is still very early, but there are clear signs of success. Already, Convex is likely to use silicon-compatible GaAs in its next generation of minisupercomputers, says technology chief Wallach, "in sufficient volume to make a vendor very happy." (In April, Robert Paluck, chief executive at Convex, joined Vitesse's board of directors.) Sun Microsystems Inc., the No. 1 workstation vendor, could use up to 20 silicon-compatible GaAs chips per system in upcoming high-end products, according to David Ditzel, manager of advanced architecture. And Joseph Zeh, group manager of large VAX engineering at Digital Equipment Corp., says, "It's not unreasonable to think" that GaAs parts would show up in Digital's products within two years.

Growth expected

With such applications in the digital mainstream, as well as GaAs' more traditional ones outside of it (such as the GaAs-based Cray-3 supercomputer), industry experts agree that the GaAs market is poised for tremendous growth. Based on discussions with users, vendors and analysts, ELECTRONIC BUSINESS projects that the worldwide merchant market for digital GaAs chips will increase 70% in 1990 to $145 million, and continue growing an average 55% a year to $540 million by 1993. Silicon compatible parts are expected to account for the lion's share of this growth and much of this business will

Linda Sue Scott

GaAs chip makers are now attacking these speed bottlenecks in computers:

- Cache control logic
- Bus arbitration control logic
- High-speed DRAM control logic
- Fractional wait-state generation logic
- Multiport register files
- Floating point processors
- Video graphics processors

come at the expense of high-speed silicon IC makers.

The silicon compatibility tactic was established by Vitesse and Gazelle, both coming on the scene after GaAs was already in trouble. "We had the ability to watch what had happened," acknowledges Vitesse's Tomasetta. Vitesse, a 1984 start-up based in Camarillo, Calif., saw that the market did not want to adopt a radically different IC technology; it wanted parts that offered improvements over existing silicon technology. Consequently, the company began developing a technology for producing digital GaAs parts that looked just like silicon parts, and which could either be used for addressing speed bottlenecks in systems, or for reducing the power requirements of a predominantly silicon system.

Increased GaAs sales expected

Vitesse turned out to be silicon compatibility's first active promoter. After it introduced an unpopular GaAs version of Advanced Micro Devices' 2901 bit-slice processor, Vitesse found success with the TTL- and ECL-compatible GaAs gate array family which it introduced in 1987. Today, Vitesse's gate arrays, which go up to 15,000 gates, are its most popular parts, according to Tomasetta. The company reached roughly $4 million in sales for fiscal 1988, and, riding a wave of major design-ins in the computer industry, Tomasetta expects Vitesse to triple its revenue to $12 million in 1989 and double it to $25 million or $30 million in 1990. By 1991, Tomasetta says 50% to 60% of Vitesse's revenue to come from high-end PC, workstation and minisupercomputer makers. The remaining will come from a mix of telecommunications, military and test equipment accounts.

The promise of silicon compatibility was obvious, says Jerry Crowley, chief executive of Gazelle, who cites this as the reason he left his CEO post at Oki Semiconductor Inc. at the end of 1986 to join the start-up. "You take an exotic material that has inherently faster properties and you tame it and make it usable by the masses."

Crowley's company, a brash marketing and design company that has raised $13.2 million from a *Who's*

How two companies figured out how to market GaAs

It is easy to figure out a marketing tactic when you're selling something popular. But it's a little more difficult when everyone laughs at you. In the case of Vitesse Semiconductor Corp. and Gazelle Microcircuits Inc., each company developed its product tactics in the midst of a market that had spurned GaAs, where the general consensus was that GaAs chip makers were courting oblivion. In doing so these companies broke with the way it had been done in GaAs' past and followed one of the principles of savvy marketing: find out what the market wants.

Vitesse's first good move was realizing it was not going to radically change computer designers' habits with GaAs — as the other GaAs chip makers were trying to do. "We started from a silicon status quo, and tried to improve on that," says Lou Tomasetta, Vitesse's president and CEO.

From there, Vitesse talked with approximately 40 potential supercomputer and mainframe customers in 1986 to find out what improvements they wanted in the silicon parts they were using. What Vitesse discovered was surprising. "What struck us was that the most important thing wasn't speed," says Tomasetta. "It was complexity and power — and then speed." This translated into Vitesse's tactic of developing silicon-compatible parts that traded off some speed for higher complexity and lower power.

Gazelle also talked to potential customers, but with an eye toward the burgeoning workstation and high-end PC market, which it had identified as a prime prospect for silicon-compatible GaAs in speed bottlenecks caused by the new breed of galloping microprocessors. Cofounders David MacMillan and Andrew Graham interviewed between 60 and 70 potential workstation and computer accounts during the company's start-up, between 1985 and 1986, to determine what computer architects require in order to step up their system's performance and what trade-offs they were willing to make, according to MacMillan, now vice president for marketing.

Gazelle and Vitesse quizzed scores of computer makers to learn what they *really* wanted

Midcourse corrections

From that information, "we made a number of midcourse corrections," MacMillian says. Among them were targeting the 22V10 programmable logic device, instead of bit-slice processors, and striving for a shortened address set-up time, a specification that would greatly boost the speed of the customers' systems.

Talking to customers was important, says MacMillan. "The basic trends ended up being pretty obvious," he says. "What becomes very difficult is how you take that trend and turn it into a product that's going to be successful."

Tomasetta of Vitesse agrees, adding that there is no distinct GaAs market for chip makers to tap. "There's not a bunch of people out there waiting for GaAs. The market can be gigantic or small, depending on the products you build." □

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Who list of venture capitalists, grabbed the industry's attention in 1988 with its first product: a GaAs version of the industry-standard 22V10 programmable logic device. The part drops into a silicon 22V10 socket and runs more than twice as fast. While Crowley is sworn to secrecy about who is designing with it, he says the names are big and they will be known by year-end.

Earlier revenue

Since customers can install the part into existing designs without modification, Gazelle will not have to wait years to see it generate revenue, he adds. Along with upcoming datacommunication products, Crowley says Santa Clara, California-based Gazelle will be a $225 million company in 1992. According to market research firm Forward Concepts Co. of Tempe, Ariz., Gazelle's 1988 sales were less than $1 million.

As for the two older GaAs chip makers, GigaBit and TriQuint, both companies now offer silicon-compatible digital products. GigaBit, based in Newbury Park, Calif., still appears to be focused, however, on GaAs-intensive applications outside the silicon mainstream, with 60% of its nearly $15 million in 1988 revenue coming from its foundry deal with Cray. "Their thrust is to place GaAs in a sea of GaAs," according to Forward Concepts president William I. Strauss. TriQuint, too, of Beaverton, Ore., is focused primarily on foundry business, where it produces chips for such customers as Gazelle. Its revenue is centered in military and telecom accounts, and it lacks a concerted push in the computer area. TriQuint reached $18 million in 1988 sales, according to Forward Concepts.

Each of the four chip makers expect digital GaAs to be commonplace in supercomputers and other low-volume, high-end machines within the next several years. But Vitesse and Gazelle say that by the end of this year, a raft of high-volume computer makers will announce systems that incorporate silicon-compatible GaAs. If this happens, it will be quite a victory. In this case, a unique market strategy will have removed GaAs from the trash heap of technologies, which includes bubble memories and Picturephones, which never quite found a mainstream market. □

Coining it: Top U.S. firms show 12% profits gain

Averaging 8.7% after-tax profit in '88, the 100 most profitable U.S. electronics firms net 64% more than U.S. industry overall

BY RAY WISE

Paced by the high-flying semiconductor, systems and government groups, the elite of the U.S. electronics industry posted another hefty year-to-year gain in profitability last year.

The ELECTRONIC BUSINESS top 100, the industry's most profitable public companies, crossed the tape last December 31 with a weighted average after-tax profit margin of 8.7%, a jump of nearly 12% over the year-earlier profitability of 7.8%.

The 1988 profit margin of the top 100 represents a 64% superiority over the 5.3% profitability of the average U.S. industrial company. The least profitable enterprise in the top 100, Kulicke & Soffa Industries Inc., a maker of semiconductor capital equipment, posted an after-tax margin of 5.2%, just about matching the all-industry average.

This latest top 100 report only heightens the stark contrast between the outstanding financial performance of high tech's leading companies and their lack of recognition on Wall Street, where their stock market valuations have been at historical lows on and off since 1983.

The top two ventures of the top 100, Micron Technology Inc., a semiconductor maker, and Symbol Technologies Inc., which is in the bar-code scanner business, had not even made the cut in last year's ELECTRONIC BUSINESS rankings of the most profitable. This time around they came in with awesome profit margins of 32.6% and 22.7%, respectively.

Such is the dynamism of this growth industry that there were eight outfits in the 1988 top 20 that weren't even eligible for the top 100 in '87. Five of the top 20 companies are in semiconductors, another five are in software, and only three make computers: Cray Research Inc., Altos Computer Systems and Compaq Computer Corp.

Technically, the office equipment group scored the biggest year-to-year profitability gain, a resounding 47%, but this was a statistical fluke. Low-margin Xerox Corp. fell out of the rankings in 1988, shrinking the office equipment group to three much more profitable companies. But Diebold Inc. and NCR Corp. slipped in profitability year to year, and Pitney Bowes Inc. was flat. What at first sight looked like a homer, turned out to be a run driven in by a base on balls.

Kevin Hawkes

The batting crown really belongs to the semiconductor group, whose after-tax profit margin improved 42% from 1987 to 1988.

Cray Research Inc., which nailed down first place in last year's top 100 with a 21.4% profit margin, fell to the fourth spot as its profitability slipped to 20.7% — a nominal decline. Cray's revenue expanded a healthy 10% last year, but the company has been corralling commercial customers, which tend to lease rather than buy. Cray derives fatter profits from its traditional marketplace — government agencies and universities — which usually purchase its super computers.

Setbacks

The biggest year-to-year profitability setback among the companies entered in both last year's and this year's top 100 fell to Tandem Computers Inc., which had a drop of 29%. But that's not as onerous as it sounds; Tandem, with an eye to its future, spends heavily, developing new markets and new technology, with the result that it does not always convert sales growth into higher earnings.

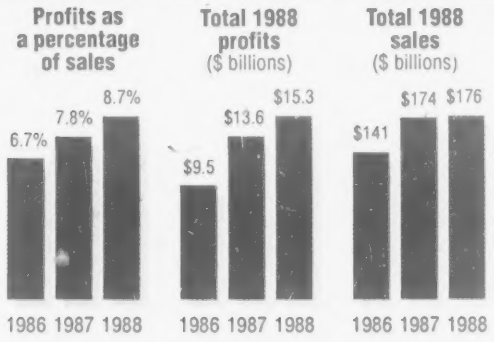
In the bombed-out computer peripherals group (income down nearly 25% in '88), a 58% plunge in the profitability of disk-drive giant Seagate Technology masked outstanding gains by other peripherals makers. Tape drive firm Archive chalked up a net margin gain of 25%, and fellow peripherals firms Applied Magnetics and Emulex saw net margin gains of 21% and more than 100%, respectively. □

Facts behind the figures

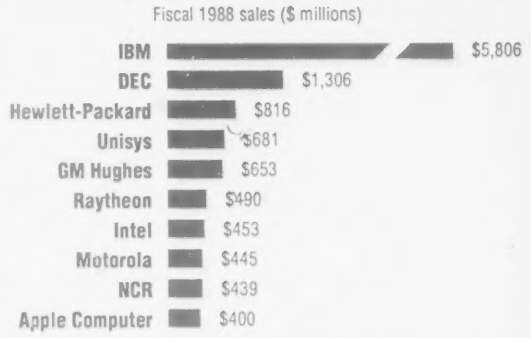
On the pages that follow, ELECTRONIC BUSINESS provides a listing of the 100 most profitable U.S. electronics firms. They are all publicly held with sales of $80 million or more, and are ranked in order of their ratio of net income to revenue for fiscal 1988.

U.S. firms have been posting better profits. Net income as a percentage of sales for the 100 most profitable climbed from 6.7% in 1986 to 7.8% in 1987, and last year it hit 8.7% — consistently better than the comparable 4.1%, 4.8% and 5.3% averages for U.S. industry in the same years.

The overall picture



Who made the most profits



Here are the sheer profits

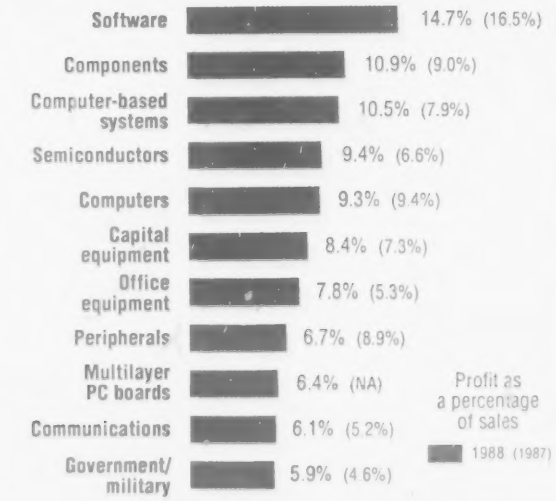
Quick quiz: On average, what was IBM's 1988 profit per day? The answer: almost $16 million. At $5.8 billion, the after-tax income of the United States electronics industry's largest company —IBM — is a figure that big boys such as NCR Corp. barely top in revenue. That figure is over twice as large as the sales of chip maker Intel Corp. and nearly three times as large as rival Compaq Computer Corp.'s sales.

Software's where the money is

In most industry segments, profitability climbed from 1987 to 1988. U.S. semiconductor makers showed one of the strongest gains — from 6.6% to 9.4% net income over sales. Components makers did well too, posting almost 11% after-tax.

Three sectors slipped in the income ratings; it's been no secret that computer peripherals firms, notably disk drive makers, have been under intense competitive pressure to make a buck. Computer makers lost some, and software firms slid, although software's still way out in front.

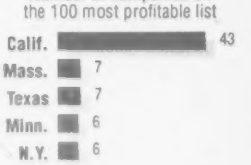
Most profitable industry segments



They don't just soak in hot tubs

Most of the most profitable U.S. electronics companies are in California — 43 of the top 100. A quick comparison with last year's list: the number of profitable companies in California grew from 37.

Hot profit spots



1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
1	Micron Technology	32.6%	$300.5	$98.0	8/88	Boise, Idaho
2	Symbol Technologies	22.7%	89.0	20.2	6/88	Bohemia, N.Y.
3	Microsoft	21.0%	590.8	123.9	6/88	Redmond, Wash.
4	Cray Research	20.7%	756.3	156.6	12/88	Minneapolis, Minn.
5	Digital Communications Associates	18.6%	227.5	42.2	6/88	Alpharetta, Ga.
6	Intel	15.8%	2,874.8	452.9	12/88	Santa Clara, Calif.
7	Chips and Technologies	15.6%	141.5	22.1	6/88	San Jose, Calif.
8	Ashton-Tate	15.6%	307.3	47.8	1/88	Torrance, Calif.
9	Xicor	15.5%	90.1	14.0	12/88	Milpitas, Calif.
10	Oracle Systems	15.2%	282.1	42.9	5/88	Belmont, Calif.
11	Cypress Semiconductor	14.9%	139.4	20.8	12/88	San Jose, Calif.
12	Computer Associates	14.4%	709.1	101.8	3/88	Garden City, N.Y.
13	Vishay Intertechnology	14.2%	109.0	15.5	6/88	Malvern, Pa.
14	Measurex	14.0%	265.2	37.1	11/88	Cupertino, Calif.
15	Medtronic	13.2%	653.3	86.5	4/88	Minneapolis, Minn.
16	Network Equipment Technologies	13.1%	90.6	11.9	3/88	Redwood City, Calif.
17	National Computer Systems	12.7%	209.2	26.5	1/89	Minneapolis, Minn.
18	Altos Computer Systems	12.6%	175.9	22.2	6/88	San Jose, Calif.
19	Lotus Development	12.6%	468.5	58.9	12/88	Cambridge, Mass.
20	Compaq Computer	12.4%	2,065.6	255.2	12/88	Houston, Texas
21	AMP	11.9%	2,670.0	319.0	12/88	Harrisburg, Pa.
22	Amdahl	11.9%	1,801.8	213.8	12/88	Sunnyvale, Calif.
23	Molex	11.8%	502.4	59.3	6/88	Lisle, Ill.
24	DEC	11.4%	11,475.4	1,305.6	6/88	Maynard, Mass.
25	Teixon	11.3%	123.9	14.0	3/88	Akron, Ohio
26	Gerber Scientific	11.2%	264.0	29.6	4/88	South Windsor, Conn.
27	Mentor Graphics	11.2%	300.8	33.5	12/88	Beaverton, Ore.
28	Stratus Computer	11.1%	265.3	29.3	12/88	Marlboro, Mass.
29	Applied Materials	11.0%	362.8	40.0	10/88	Santa Clara, Calif.
30	Intergraph	11.0%	800.2	88.0	12/88	Huntsville, Ala.
31	Novell	10.8%	281.2	30.4	10/88	Provo, Utah
32	Silicon Systems	10.5%	120.8	12.7	9/88	Tustin, Calif.
33	Apple Computer	9.8%	4,071.4	400.3	9/88	Cupertino, Calif.
34	Integrated Device Technology	9.6%	121.1	11.6	3/88	Santa Clara, Calif.
35	Richardson Electronics	9.5%	118.3	11.2	5/88	La Fox, Ill.
36	Teradata	9.5%	89.5	8.5	6/88	Los Angeles, Calif.
37	ADC Telecommunications	9.4%	179.9	17.0	10/88	Bloomington, Minn.
38	IBM	9.2%	59,681.0	5,806.0	12/88	Armonk, N.Y.
39	3Com	8.9%	251.9	22.5	5/88	Santa Clara, Calif.
40	Pitney Bowes	8.9%	2,649.9	237.0	12/88	Stamford, Conn.
41	Plantronics	8.9%	121.0	10.7	6/88	San Jose, Calif.
42	Atari	8.7%	452.2	39.4	12/88	Sunnyvale, Calif.
43	Tellabs	8.7%	155.4	13.5	12/88	Lisle, Ill.
44	Analog Devices	8.6%	439.2	38.0	10/88	Norwood, Mass.
45	Network Systems	8.6%	131.5	11.4	12/88	Minneapolis, Minn.
46	Systematics	8.6%	179.5	15.4	8/88	Little Rock, Ark.
47	Archive	8.6%	122.7	10.5	9/88	Costa Mesa, Calif.
48	Tandy	8.3%	3,793.8	316.4	6/88	Fort Worth, Texas
49	Hewlett-Packard	8.3%	9,831.0	816.0	10/88	Palo Alto, Calif.
50	Silicon Graphics	8.2%	152.6	12.5	6/88	San Jose, Calif.

(Continued)

1988's most profitable U.S. companies

Rank	Company	Profit as a percentage of sales	Fiscal year 1988 sales ($ millions)	Fiscal year 1988 profits ($ millions)	Fiscal year ended	Location
51	Applied Magnetics	8.1%	$293.0	$23.7	9/88	Goleta, Calif.
52	Conner Peripherals	7.9%	256.6	20.3	12/88	San Jose, Calif.
53	KLA Instruments	7.8%	112.9	8.8	6/88	Santa Clara, Calif.
54	Iomega	7.7%	111.5	8.6	12/88	Roy, Utah
55	Ask Computer Systems	7.6%	142.4	10.8	6/88	Los Altos, Calif.
56	NCR	7.3%	5,989.9	439.3	12/88	Dayton, Ohio
57	Emulex	7.3%	125.1	9.1	6/88	Costa Mesa, Calif.
58	Tandem Computers	7.2%	1,314.7	94.5	9/88	Cupertino, Calif.
59	MTS Systems	7.1%	128.9	9.1	9/88	Minneapolis, Minn.
60	Watkins-Johnson	7.0%	292.2	20.6	12/88	Palo Alto, Calif.
61	Diceon Electronics	7.0%	140.7	9.9	9/88	Irvine, Calif.
62	Diebold	7.0%	450.6	31.3	12/88	Canton, Ohio
63	BancTec	6.9%	93.4	6.4	3/88	Dallas, Texas
64	Unisys	6.9%	9,902.0	680.6	12/88	Detroit, Mich.
65	Data-Design Laboratories	6.8%	107.0	7.3	6/88	Cucamonga, Calif.
66	AVX	6.7%	408.9	27.6	12/88	Great Neck, N.Y.
67	Dynatech	6.7%	367.8	24.5	3/88	Burlington, Mass.
68	Burr-Brown	6.5%	176.7	11.5	12/88	Tucson, Ariz.
69	Triad Systems	6.5%	127.4	8.3	9/88	Livermore, Calif.
70	Oak Industries	6.5%	197.8	12.9	12/88	Rancho Bernardo, Calif.
71	Sun Microsystems	6.3%	1,051.6	66.4	6/88	Mountain View, Calif.
72	LSI Logic	6.3%	378.9	23.8	12/88	Milpitas, Calif.
73	Ultimate	6.2%	209.2	13.0	4/88	East Hanover, N.J.
74	Intermec	6.1%	85.2	5.2	3/88	Lynnwood, Wa.
75	Wyse Technology	6.1%	456.6	28.0	3/88	San Jose, Calif.
76	Seagate Technology	6.1%	1,266.0	77.3	6/88	Scotts Valley, Calif.
77	Finnigan	6.0%	130.7	7.8	12/88	San Jose, Calif.
78	Raytheon	6.0%	8,192.0	489.6	12/88	Lexington, Mass.
79	Bolt Beranek and Newman	5.9%	305.2	18.1	6/88	Cambridge, Mass.
80	DSC Communications	5.9%	339.7	20.0	12/88	Plano, Texas
81	Scientific-Atlanta	5.8%	508.6	29.7	6/88	Atlanta, Ga.
82	Texas Instruments	5.8%	6,294.8	366.3	12/88	Dallas, Texas
83	MAI Basic Four	5.8%	420.8	24.5	9/88	Tustin, Calif.
84	GM Hughes Electronics	5.8%	11,243.6	653.3	12/88	Detroit, Mich.
85	Rexon	5.8%	155.5	9.0	9/88	Culver City, Calif.
86	General Instrument	5.7%	1,155.5	66.2	2/88	New York, N.Y.
87	Eldec	5.6%	104.1	5.9	3/88	Lynnwood, Wash.
88	Cipher Data Products	5.6%	185.4	10.4	6/88	San Diego, Calif.
89	Valid Logic Systems	5.6%	108.4	6.1	12/88	San Jose, Calif.
90	Dell Computer	5.6%	257.8	14.4	1/89	Austin, Texas
91	Western Digital	5.6%	768.3	43.0	6/88	Irvine, Calif.
92	Fluke	5.5%	224.5	12.4	9/88	Everett, Wash.
93	Park Electrochemical	5.5%	128.1	7.0	2/88	Lake Success, N.Y.
94	Andrew	5.5%	253.5	13.9	9/88	Orland Park, Ill.
95	Concurrent Computer	5.5%	263.1	14.4	6/88	Tinton Falls, N.J.
96	MSI Data	5.5%	90.2	4.9	3/88	Costa Mesa, Calif.
97	Convex Computer	5.4%	105.6	5.7	12/88	Richardson, Texas
98	Sparton	5.4%	206.3	11.2	6/88	Jackson, Mich.
99	Motorola	5.4%	8,250.0	445.0	12/88	Schaumburg, Ill.
100	Kulicke and Soffa	5.2%	83.5	4.4	9/88	Willow Grove, Pa.

Source: ELECTRONIC BUSINESS

1988's most profitable U.S. companies by industry segment

Capital equipment

	Profit as a percentage of sales	1988 rank
Vishay Intertechnology	14.2%	13
Gerber Scientific	11.2%	26
Applied Materials	11.0%	29
Hewlett-Packard	8.3%	49
KLA Instruments	7.8%	53
MTS Systems	7.1%	59
Fluke	5.5%	92
Kulicke and Soffa	5.2%	100
Weighted average	**8.4%**	

Communications

	Profit as a percentage of sales	1988 rank
Digital Communications Associates	18.6%	5
Network Equipment Technologies	13.1%	16
Novell	10.8%	31
ADC Telecommunications	9.4%	37
3Com	8.9%	39
Tellabs	8.7%	43
Network Systems	8.6%	45
Dynatech	6.7%	67
Bolt Beranek and Newman	5.9%	79
DSC Communications	5.9%	80
Scientific-Atlanta	5.8%	81
General Instrument	5.7%	86
Andrew	5.5%	94
Motorola	5.4%	99
Weighted average	**6.1%**	

Components (other than semiconductors)

	Profit as a percentage of sales	1988 rank
AMP	11.9%	21
Molex	11.8%	23
AVX	6.7%	66
Oak Industries	6.5%	70
Eldec	5.6%	87
Weighted average	**10.9%**	

Computer-based systems

	Profit as a percentage of sales	1988 rank
Symbol Technologies	22.7%	2
Measurex	14.0%	14
National Computer Systems	12.7%	17
Telxon	11.3%	25

(Continued)

Computer-based systems (continued)

	Profit as a percentage of sales	1988 rank
Mentor Graphics	11.2%	27
Ask Computer Systems	7.6%	55
BancTec	6.9%	63
Triad Systems	6.5%	69
Finnigan	6.0%	77
Valid Logic Systems	5.6%	89
MSI Data	5.5%	96
Weighted average	**10.5%**	

Computers

	Profit as a percentage of sales	1988 rank
Cray Research	20.7%	4
Altos Computer Systems	12.6%	18
Compaq Computer	12.4%	20
Amdahl	11.9%	22
DEC	11.4%	24
Stratus Computer	11.1%	28
Intergraph	11.0%	30
Apple Computer	9.8%	33
Teradata	9.5%	36
IBM	9.2%	38
Atari	8.7%	42
Tandy	8.3%	48
Silicon Graphics	8.2%	50
Tandem Computers	7.2%	58
Unisys	6.9%	64
Sun Microsystems	6.3%	71
MAI Basic Four	5.8%	83
Rexon	5.8%	85
Dell Computer	5.6%	90
Concurrent Computer	5.5%	95
Convex Computer	5.4%	97
Weighted average	**9.3%**	

Government

	Profit as a percentage of sales	1988 rank
Watkins-Johnson	7.0%	60
Raytheon	6.0%	78
GM Hughes Electronics	5.8%	84
Spartor	5.4%	98
Weighted average	**5.9%**	

Multilayer circuit boards

	Profit as a percentage of sales	1988 rank
Diceon Electronics	7.0%	61
Data-Design Laboratories	6.8%	65
Park Electrochemical	5.5%	93
Weighted average	**6.4%**	

Office equipment

	Profit as a percentage of sales	1988 rank
Pitney Bowes	8.9%	40
NCR	7.3%	56
Diebold	7.0%	62
Weighted average	**7.8%**	

Peripherals

	Profit as a percentage of sales	1988 rank
Archive	8.6%	47
Applied Magnetics	8.1%	51
Conner Peripherals	7.9%	52
Iomega	7.7%	54
Emulex	7.3%	57
Intermec	6.1%	74
Wyse Technology	6.1%	75
Seagate Technology	6.1%	76
Cipher Data Products	5.6%	88
Weighted average	**6.7%**	

Semiconductors

	Profit as a percentage of sales	1988 rank
Micron Technology	32.6%	1
Intel	15.8%	6
Chips and Technologies	15.6%	7
Xicor	15.5%	9
Cypress Semiconductor	14.9%	11
Silicon Systems	10.5%	32
Integrated Device Technology	9.6%	34
Richardson Electronics	9.5%	35
Analog Devices	8.6%	44
Burr-Brown	6.5%	68
LSI Logic	6.3%	72
Texas Instruments	5.8%	82
Western Digital	5.6%	91
Weighted average	**9.4%**	

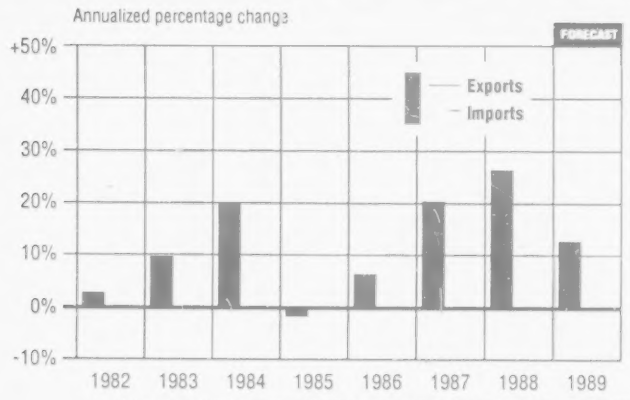
Software

	Profit as a percentage of sales	1988 rank
Microsoft	21.0%	3
Ashton-Tate	15.6%	8
Oracle Systems	15.2%	10
Computer Associates	14.4%	12
Lotus Development	12.6%	19
Systematics	8.6%	46
Ultimate	6.2%	73
Weighted average	**14.7%**	

Net profits are from continuing operations after taxes and before extraordinary items

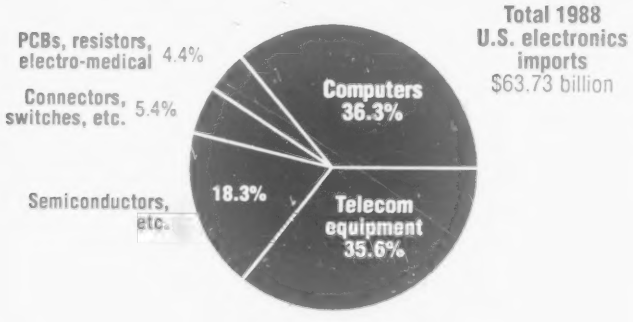
Source: ELECTRONIC BUSINESS

U.S. electronics exports and imports



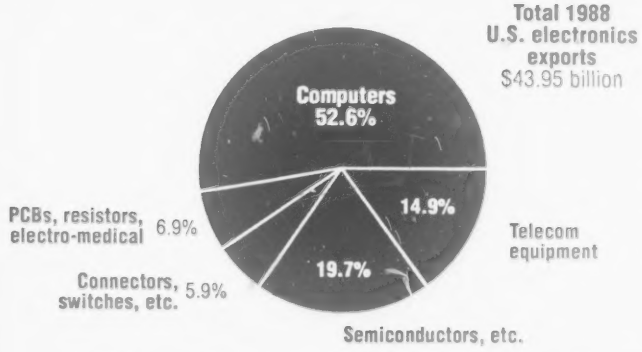
Data source: U.S. International Trade Administration; Forecast: Cahners Economics

1988 U.S. electronics imports



Data source: U.S. International Trade Administration; Forecast: Cahners Economics

1988 U.S. electronics exports



Data source: U.S. International Trade Administration; Forecast: Cahners Economics

U.S. electronics exports grow and grow

U.S. electronics manufacturers exported $11.83 billion worth of products in the fourth quarter of 1988 — a surge of 19% over the fourth quarter 1987 level, according to International Trade Administration estimates. The U.S. dollar's decline over the past two years was just what the electronics industry needed. U.S. electronics exports expanded 20% in 1987 and another 26% in 1988, for an annual total last year of $43.95 billion.

The depreciating greenback also finally resulted in some noticeable softening in the growth rate of electronics imports. In the final quarter of last year, imports of electronics products tallied $17.63 billion, a gain of 15.5% over the same quarter of 1987. Although still a hefty increase, that growth was down from the gains recorded in the first three quarters of last year. For all of 1988, electronics imports advanced 18.8% to $63.73 billion.

Unfortunately for the U.S. trade picture, the electronics trade deficit in 1988 weighed in at $19.77 billion — up almost 5% from the $18.84 billion the year before. With the exceptions of computing machines, electromedical equipment, and printed circuit boards, the U.S. imported more than it exported last year. Not since 1982 has U.S. electronics trade run a surplus.

The appreciating dollar earlier in the decade left the gates wide open for a flood of imports into the U.S. and, at the same time, influenced U.S. companies to locate offshore. Thus, the development of foreign economies and multinational corporations has changed the patterns of global trade.

Forecasting future trade developments

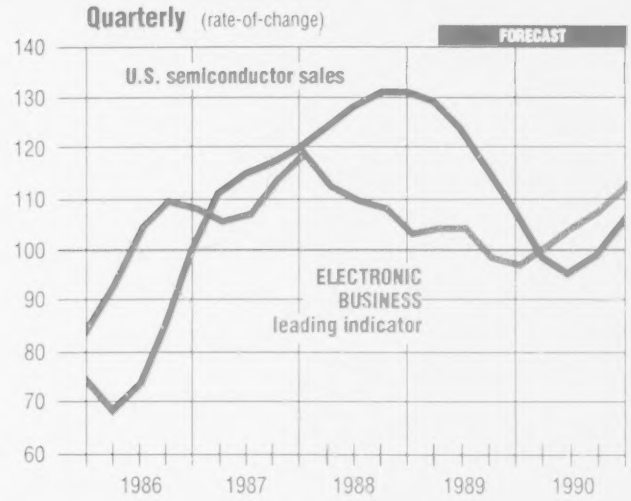
According to our estimates at Cahners Economics, exports of electronics products will continue to grow this year and next although the rate is likely to be halved from the 1988 pace as the dollar stabilizes. A weaker U.S. economy will also put the lid on import growth, keeping the annual increase below the export rate for the third straight year.

Of course, any forecast on future export and import trends depends on forecasts for the U.S. dollar. Forecasting the dollar is an especially risky business, but Cahners Economics assumes the value of the dollar will rise a marginal 0.5% to 1% in 1989. The ultimate result: the big bonuses to U.S. exporters from a sharply falling dollar clearly appear to be over for the next 12 months.

MADELINE FRANCHI, ELIZABETH B. BAATZ

This topic is scheduled to appear again in the December 11th issue.

ELECTRONIC BUSINESS leading indicator



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass., 02158, or call (617) 558-4368

The ELECTRONIC BUSINESS leading indicator held relatively steady at 102.7 in February, down from a revised 103.3 in January. Unexpected strength in U.S. semiconductor bookings is helping to hold up the indicator. The question now: How long will this plateau last? Cahners' forecast suggests the indicator will drop to 95 by September and then rise again afterward.

Source: Cahners Economics

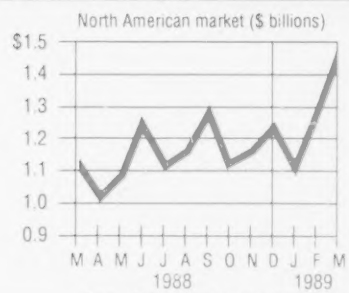
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1988 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Feb.)	102.7	103.3	112.1	107.6
U.S. semiconductor bookings ($ millions, 3-month average, March)	$1,345	$1,243	$1,142	$1,178
Weekly hours of semiconductor production workers (monthly average, Feb.)	39.3	40.0	40.2	40.2
Electronic components leadtime index (1977 = 100, April)	117.7	117.7	106.5	108.9
S&P's semiconductor stock price index (1970 =10, monthly average, Mar.)	47.4	51.0	59.2	54.4
Change in electronic components inventories ($ millions, SA, Feb.)	+$94	+$50	+$123	+$80
Contract and orders for plant and equipment ($ billions, SA, Feb.)	$41.0	$45.0	$39.5	$39.4

SA = seasonally adjusted; all other data is not seasonally adjusted

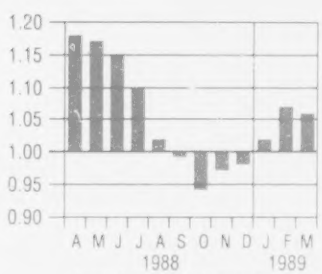
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



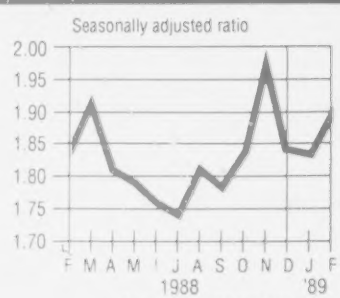
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department